

DETAILED REPORTS

1. Physical Oceanography and Underway Environmental Observations; submitted by Mark R. Prowse (Leg I), Derek J. Needham (Legs I & II), Michael A. Soule (Leg II) and David A. Demer (Leg II).

1.1 Objectives: Objectives were to 1) collect and process physical oceanographic data in order to identify and map oceanographic frontal zones; and 2) collect and process environment data underway in order to describe sea surface and meteorological conditions experienced during the surveys. These data may be used to describe the physical circumstances associated with various biological observations as well as provide a detailed record of the ship's movements and the environmental conditions encountered.

1.2 Accomplishments:

1.2.1 CTD/Carousel Stations: Ninety-two of the 95 planned CTD/carousel casts were made on Leg I (Survey A, Stations A15-15 to A14-12) with 3 casts being cancelled because of bad weather (Stations, A15-09, A14-10 and A13-09). An additional 4 casts (Survey prefix B) were done during the *ad hoc* survey north of Cape Sherriff after the main survey was completed during Leg I. An additional "blue water" cast (Station BWZ) was done at 61° 08'S during the transit north at the end of Leg I.

A total of 95 casts were completed during the main Leg II survey (Survey D). An additional 21 casts were performed between the 18th and 23rd February 2002 during the Near Shore Survey north of Cape Shirreff, Livingston Island. A single "blue water" cast (Station CWZ) was done at 58° 55.9'S during the transit from Punta Arenas to the survey area at the beginning of Leg II. Water samples were collected at discrete depths on all casts and used for salinity verification and phytoplankton analysis and these were drawn from the Niskin bottles by the Russian scientific support team. See Figure 2 in Introduction section for station locations. The Guildline Autosol difficulties experienced last year repeated themselves again during Leg I, despite the recent servicing of the unit. Sample readings were unstable and showed a random increase with time that could not be corrected. Samples from a representative cross-section of stations and depths were retained for later analysis. The faulty unit was replaced with a spare unit during the changeover between Legs I and II in Punta Arenas. This unit was also found to be unreliable and necessitated the retention of samples for later analysis. Comparison of the Seabird TSG salinity data with 7m CTD salinity data showed very good agreement, while the sea temperature showed the TSG to be 0.64°C higher than the CTD 7m data. This agrees with the 0.6°C measured in previous years and can be attributed to the internal positioning of the temperature sensor and heating effects of the seawater pump.

A comparison of the dissolved oxygen levels in the carousel water samples and the levels measured during the casts (via the O₂ sensor) was not attempted.

1.2.2 Underway Environmental Observations: Environmental and vessel positional data was collected for a total of 32 and 28 days for Legs I and II respectively via the Scientific Computer

System (SCS) software package (Software Version 3.2) running under Windows 2000 on a Pentium III (450mHz) PC. A Coastal Environmental Company Weatherpak system was installed on the port side of the forward A-frame in front of the bridge and was used as the primary meteorological data acquisition system. The data provided covered surface environmental conditions encountered over the entire AMLR survey area for the duration of the cruise including transits to and from Punta Arenas.

1.3 Methods:

1.3.1 CTD/Carousel: Water profiles were collected with a Sea-Bird SBE-9/11+ CTD/carousel water sampler equipped with 10 new Niskin sampling bottles. An eleventh older bottle was added to the carousel to accommodate increased surface water (5 meters) volume requirements for phytoplankton analysis at selected stations. At these stations, this bottle was rigged to the same trigger as the 10th bottle to ensure that they closed simultaneously. On routine stations the 11th bottle allowed for an additional 15m sample to be collected. Profiles were limited to a depth of 750 meters or 5 meters above the sea bottom when shallower. A Data Sonics altimeter was used to stop the CTD above the bottom on the shallow casts. Standard sampling depths were 750m, 200m, 100m, 75m, 50m, 40m, 30m, 20m, 15m, 10m and 5m, except when two 5m samples were collected and the 15m sample was skipped. A Sea-Bird Dissolved Oxygen (DO) sensor (SeaBird, Model 13-02-B), two fluorometers (Wetlabs), two transmissometers (Wetlabs, CStar), one red and one blue spectrum and a PAR sensor (Biospherical 2pi) provided additional water column data during Legs I and II. Scan rates were set at 24 scans/second during both down and upcasts. Sample bottles were only triggered during upcasts. Plots of the down traces were generated and stored with the CTD cast log sheets. A second plot and an enlarged 0-300m plot was provided to the phytoplankton group, together with CTD mark files (reflecting data from the cast at bottle triggering depths) and processed up and down traces. Data from casts were averaged over 1m bins and saved separately as up and down traces during post processing. The data were logged and bottles triggered using Seabird Seasave Win32 Vs 5.22 and the data processed using SBE Data Processing Vs 5.22. The new dual screen configuration of the PC and the improvements to Seasave allowed additional windows of information to be displayed during the CTD casts, which greatly improved the information available to the operator (this included real-time T-S plots). Downcast data was re-formatted using a SAS script and then imported into Ocean Data View for further analysis.

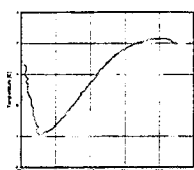
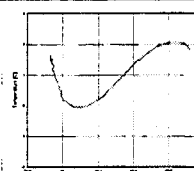
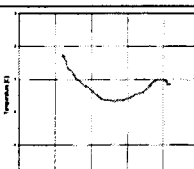
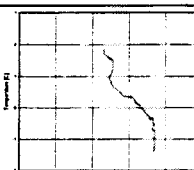
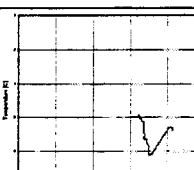
1.3.2 Underway Data: Weather data inputs were provided by the Coastal Environmental Systems Company Weatherpak via a serial link and included relative wind speed and direction, barometric pressure, air temperature and irradiance (PAR). The relative wind data were converted to true speed and true direction by the internally derived functions of the SCS logging software. Measurements of sea surface temperature and salinity output in a serial format by the SeaBird SBE21 thermosalinograph (TSG) were also integrated into the logged data. Ships' position and heading were provided in NMEA format via a Furuno GPS Navigator and Magnavox MX 200 respectively. No underway transmissometer and fluorometer measurements were made during the routine survey. However an underwater transmissometer unit was experimentally interfaced via the Fluke Data Bucket A/D converter to the seawater flow-through line downstream of the Seabird TSG. Unfortunately bubble formation interfered with the data

quality. Serial data lines were interfaced to the logging PC via a Digi-ports 16/EM serial multiplexor.

1.4 Results and Tentative Conclusions:

1.4.1 Oceanography: The position of the polar frontal zone, identified mostly by sea temperature change and minor salinity variation, was located from underway logged data during all 4 transits to and from Punta Arenas and the South Shetland Island survey area. This zone is normally found between 57-58°S. During the south transit for Leg I, the front was centred around 58° 30'S (encompassed by 58-59°S), shifting further south and becoming less clearly delineated between 60°S to 61° 30'S on the north-bound transit. The latter is possibly due to the more westward crossing of the Drake Passage (approximately 70°W compared with the 68°W southward transit). On the southbound transit for Leg II it had shifted further north between 57° 30'S and 58° 40'S. On the return northbound transit at the end of Leg II the zone had compressed and lay between 57° 20'S and 57° 50'S (Figure 1.1). As in previous years an attempt was made to group stations with similar temperature and salinity profiles into five water zones as defined in Table 1.1. While these classifications could generally be adhered to, the occurrence of Zone I water was less than expected during Legs I and II. While the southern boundary of the Antarctic Circumpolar Current (SB-ACC) was clearly delineated within the survey area by the presence of the 1.8°C isotherm and the 4.1mL/L dissolved oxygen level (markers defined by Hofmann *et al.*, 1996), the T-S curves of the CTD casts north of this boundary were not conclusively Zone I water. Current screening criteria specify the salinity at minimum temperature (approximately -1.0°C) should be 34.0 ppt, but during Leg I only 3 stations in the offshore western area met this criteria. While conforming to the general T-S shape, most other Zone I stations with similar characteristics had higher salinities at the temperature minimum. In comparing the data of 2000/01 and 2001/02, the normal winter water (WW) sub-surface minimum was neither as extensive, nor as cold during 2001/02, possibly a result of poor sea-ice development in preceding winters (Hewitt, R.P. pers. comms; Hewitt, R.P., 1997). Water Zones II and III were identified in the southwest to northeast axis of the survey area with a clear meandering of both Zone II water and the SB-ACC into the north-east in the area north of Elephant Island. Zone IV water can be seen extending from within the Bransfield Strait (south of Livingston Island) past King George Island, narrowing and passing south of Elephant Island and being pushed north of Clarence Island by the Zone V intrusion from the southeast. Zone V water dominates the extreme southeast of the area, intruding into the coastal-shelf area of the south Bransfield Strait. It is the tentative conclusion that while the southern area conforms to expectations, the northern area of the survey is dominated by transitional water and that the normal extent of Zone I intrusion from the northwest was reduced this season. This was also evident during Leg II where the SB-ACC appeared to have shifted northwards particularly in the northeast of the survey area. Note that although stations over the shelf regions were classified as Zone III, reduced data sets (resulting from the shallower water encountered) introduced a degree of uncertainty into the precision of Zone allocations.

Table 1.1. Water Zone definitions applied for Legs I and II, AMLR 2001/02.

	T/S Relationship			Typical TS Curve (from 2001/02)
	Left	Middle	Right	
Water Zone I (ACW)	Pronounced V shape with V at $<0^{\circ}\text{C}$			
Warm, low salinity water, with a strong subsurface temperature minimum, Winter Water, approx. -1°C , 34.0ppt salinity) and a temperature maximum at the core of the CDW near 500m.	2 to $>3^{\circ}\text{C}$ at 33.7 to 34.1ppt	$\leq 0^{\circ}\text{C}$ at 33.3 to 34.0 ppt	1 to 2°C at 34.4 to 34.7ppt (generally $>34.6\text{ppt}$)	
Water Zone II (Transition)	Broader U-shape			
Water with a temperature minimum near 0°C , isopycnal mixing below the temperature minimum and CDW evident at some locations.	1.5 to $>2^{\circ}\text{C}$ at 33.7 to 34.2ppt	-0.5 to 1°C at 34.0 to 34.5ppt (generally $>0^{\circ}\text{C}$)	0.8 to 2°C at 34.6 to 34.7ppt	
Water Zone III (Transition)	Backwards broad J-shape			
Water with little evidence of a temperature minimum, mixing with Zone II transition water, no CDW and temperature at depth generally $>0^{\circ}\text{C}$	1 to $>2^{\circ}\text{C}$ at 33.7 to 34.0ppt	-0.5 to 0.5°C at 34.3 to 34.4ppt (note narrow salinity range)	$\leq 1^{\circ}\text{C}$ at 34.7ppt	
Water Zone IV (Bransfield Strait)	Elongated S-shape			
Water with deep temperature near -1°C , salinity 34.5ppt, cooler surface temperatures.	1.5 to $>2^{\circ}\text{C}$ at 33.7 to 34.2ppt	-0.5 to 0.5°C at 34.3 to 34.45ppt (T/S curve may terminate here)	$<0^{\circ}\text{C}$ at 34.5ppt (salinity $< 34.6\text{ppt}$)	
Water Zone V (Weddell Sea)	Small fish-hook shape			
Water with little vertical structure and cold surface temperatures near or $< 0^{\circ}\text{C}$.	1°C (+/- some) at 34.1 to 34.4ppt	-0.5 to 0.5°C at 34.5ppt	$<0^{\circ}\text{C}$ at 34.6ppt	

The MATLAB program written during AMLR 2000/01 was used in an attempt to reduce any subjective influence on the classification of water types (see AMLR 2000/01 Field Season Report, Chapter 1 for details). Although the program was essentially a fairly coarse first attempt to classify water zones in the survey area, it supported the contention that Zone I water is less prevalent in the northwest and provides a valuable objective confirmation. The distinction between Zone IV and V water in the southeastern quadrant seemed less robust and it did not

agree well with the visually allocated classifications (Figure 1.2). Further refinements, possibly broadening the range of criteria used, may be required for this part of the algorithm. Vertical temperature profiles generated from CTD data on transects W05, EI03, and EI07 (Figure 1.3) show an apparent influx of warmer surface water during Leg II.

1.4.2 Underway Data: Environmental data was recorded for the duration of both Legs I and II and for the transits between Punta Arenas and the survey area (except for TSG data which is not available for transits in the Strait of Magellan). Very short periods of data were lost periodically while the logging PC was routinely reset. Processed data were averaged and filtered over 5-minute intervals to reduce the effects of transients, particularly in data recorded from the thermosalinograph, which was sometimes prone to the effects of aeration (Figures 1.4 & 1.5).

Comparisons between the weather conditions experienced during Legs I and II during the surveys show significant differences, primarily between wind direction and PAR readings (Figures 1.4 & 1.5).

During Leg I the wind blew predominantly from the west (southwest and northwest) with occasional short spells of easterlies, peaking to 20 knots. During Leg II recorded wind speeds averaged less than Leg I, the wind blowing mainly from the north and northeast. Short periods of southerly winds were also recorded (Figure 1.6).

The mean air temperatures generally remained above zero for both Legs, with the lowest recorded survey temperature of approx. -1°C occurring on the 7th March during Leg II.

Weather for Leg I was most often partly-cloudy or overcast, a number of days of poor visibility and some fog were experienced and a few light snowfalls were recorded, including one shortly after commencing the northbound Drake crossing. Conditions were similar during Leg II with the PAR sensor indicating reduced levels of photosynthetic radiation. There was a noticeable reduction in the number of icebergs seen in the survey in comparison with the AMLR 2000/01 survey.

1.5 Disposition of Data: Data are available from Roger Hewitt, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA, 92037; phone/fax +1 (858) 546-5602/5608; email: Roger.Hewitt@noaa.gov.

1.6 Acknowledgements: The co-operation and assistance of the Russian technical support staff was always outstanding. All requests for assistance were dealt with efficiently and in a thoroughly professional manner.

1.7 Problems and Suggestions: At the start of Leg I, the "Sea Cable" fuse on the CTD deck unit blew when supplying CTD underwater unit S No. 0455. On dismantling the unit, the PSU was found to be faulty and it was returned to Seabird, U.S.A. for test and repair. The spare CTD unit (0454) was then used for Leg I. Corrosion of the Y-lead connector for the two Wetlabs Transmissometers attached to CTD bulkhead connector was detected when it was inspected after a change in data for transect EI07 was noted. One of the CTD connector pins was also corroded

but serviceable. All pins on the bulkhead connector were cleaned and the interconnecting cable was replaced with a spare.

Prior to the start of the Leg II survey, the CTD underwater unit (S. No. 0913966-0454) was closely inspected and signs of leakage were clearly evident on a number of bulkhead connectors, the worst affected being the fluorometer and PAR channels. On opening unit 0454, evidence of corrosion was found in the vicinity of the "O-ring" seals. It is highly likely that the underwater casing will have to be replaced when the unit is next serviced. The underwater unit was therefore replaced at the start of Leg II with S. No. 0455 (the unit which was returned to Seabird for PSU repairs at the start of Leg I). The thermosalinograph worked well although data integrity was occasionally affected during periods of bad weather when excessive aeration occurred.

The Autosal Salinometer was again prone to apparent instability and it proved impossible, despite email assistance from the servicing agents, to accurately standardize the unit. Following the problems experienced last year the unit was serviced but the new thermocouple pairs installed to control the temperature bath temperature may not be to the required standard and will need to be tested. It is recommended that the unit again be returned to the manufacturers for service and calibration prior to the next cruise or that serious consideration be given to the acquisition of a new, current technology unit since the existing unit is more than 20 years old. A replacement unit obtained for Leg II failed after a short period and selected water samples had to be retained for later analysis.

The Coastal Environmental Systems Weatherpak originally installed (No. 798) was found to have a defective air pressure sensor during initial setup. The faulty unit was opened and inspected and a plug on the sensor circuitry was found to be partially disconnected and the pins badly bent, probably a result of impact with the casing during re-assembly after annual servicing by the agents. The fault was repaired and the unit was deployed on R/V *Ernest*. The spare unit (No. 797) was fitted on the R/V *Yuzhmorgeologiya* and this worked reliably for the full duration of Legs I and II of the cruise. The overscale humidity values (up to 110%), which occurred whenever rainy or foggy conditions arose during the survey, are most likely due to saturation of the sensor.

The CTD/SCS logging PC, currently a Pentium 450MHz, required periodic re-booting to eliminate a gradual slowing of the system. This slowing resulted in delayed bottle triggering response times and small deviations from the preferred sampling depths. The Windows-based Seabird data capture program Seasave and SBE Data Processing suite were used for logging and processing respectively. Since the slow-down was not noted last season when the same PC was used for DOS-based Seabird programs, it is suspected that the new software versions utilise a greater percentage of system resources causing the system to become sluggish over extended periods of time. It was noted that when processing was being done in the background and a cast was initiated, overflow errors resulted. Eventual upgrade to a faster processor should be considered.

1.8 References:

Hewitt, R.P. 1997. Areal and seasonal extent of sea-ice cover off the northwestern side of the Antarctic Peninsula: 1979 to 1996. *CCAMLR Science* 4: 65-73.

Hofmann, E.E., Klinck, J.M., Lascara C.M., and Smith, D.A. 1996. Water mass distribution and circulation west of the Antarctic Peninsula and including Bransfield Strait. *In*: Ross, R.M., Hofmann, E.E., and Quetin, L.B. (Editors). *Foundations for Ecological Research West of the Antarctic Peninsula*, American Geophysical Union, Washington DC, Antarctic Research Series 70, pp. 61-80.

Schlitzer, R. 2001. Ocean Data View. <http://www.awi.bremerhaven.de/GEO/ODV>.

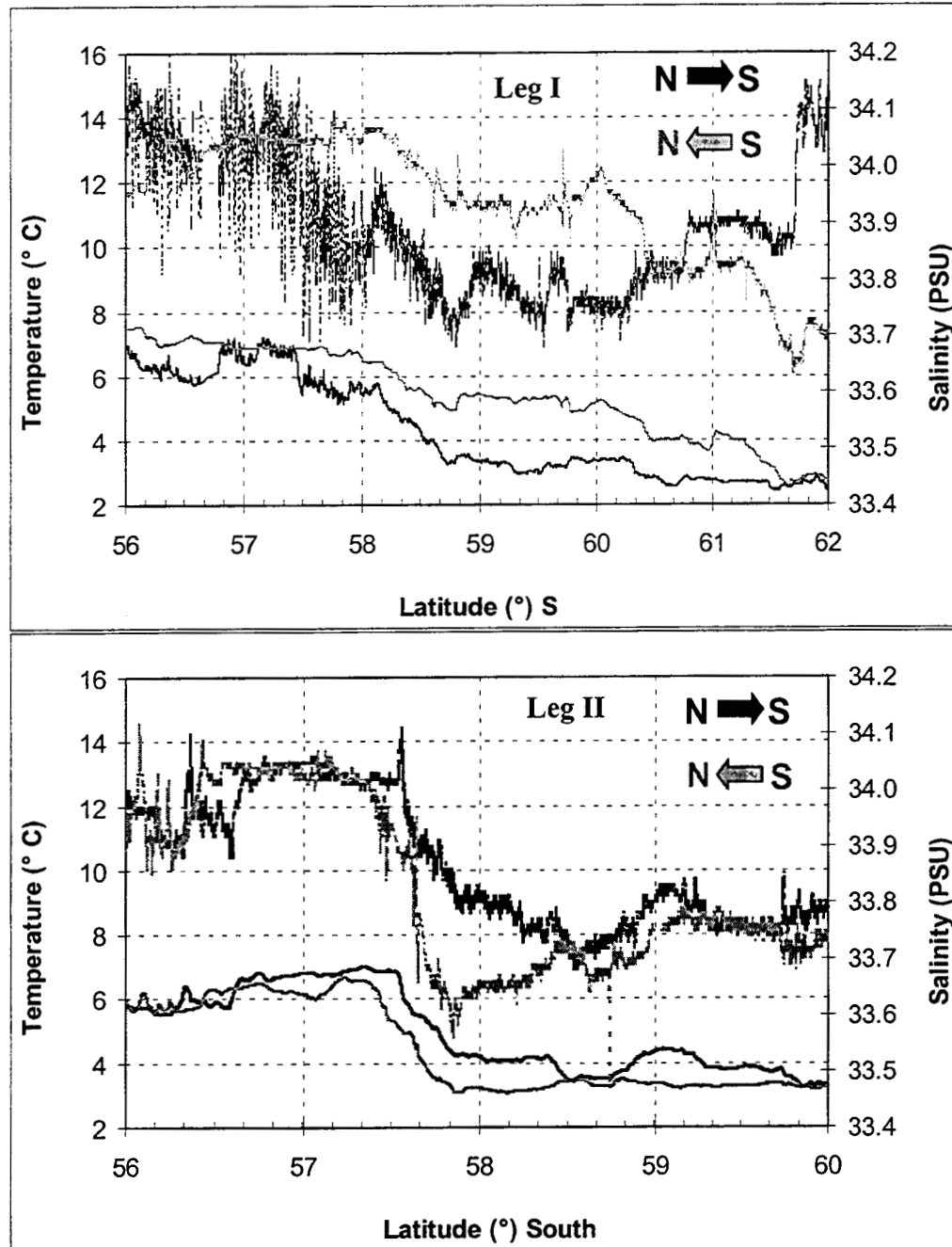


Figure 1.1. The position of the polar fronts as determined for AMLR 2001/02 Legs I (top) and II (bottom), from measurements of sea surface temperature (solid line) and salinity (broken line) for the south and north transits to and from the South Shetland Islands survey area.

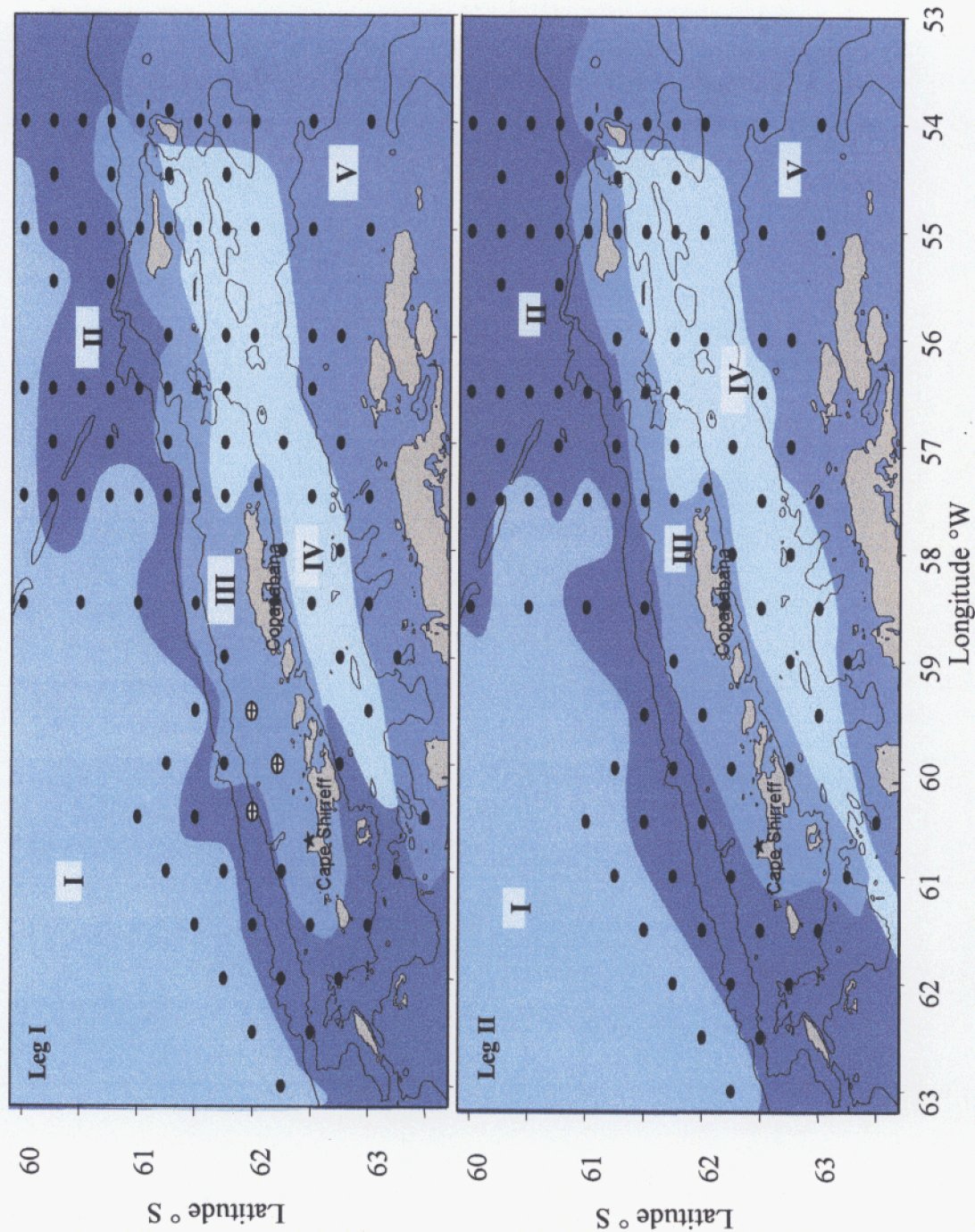


Figure 1.2. The five water zones derived from scrutinising T-S characteristics for Legs I (top) and II (bottom panel). Note that although stations over the shelf regions were classified as Zone III, the reduced data sets (resulting from the shallower water encountered), introduced a degree of uncertainty into the precision of the allocations. Stations aborted due to bad weather conditions (Leg I) are indicated by.

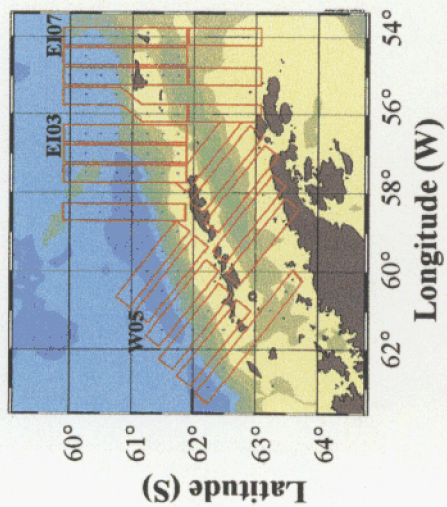
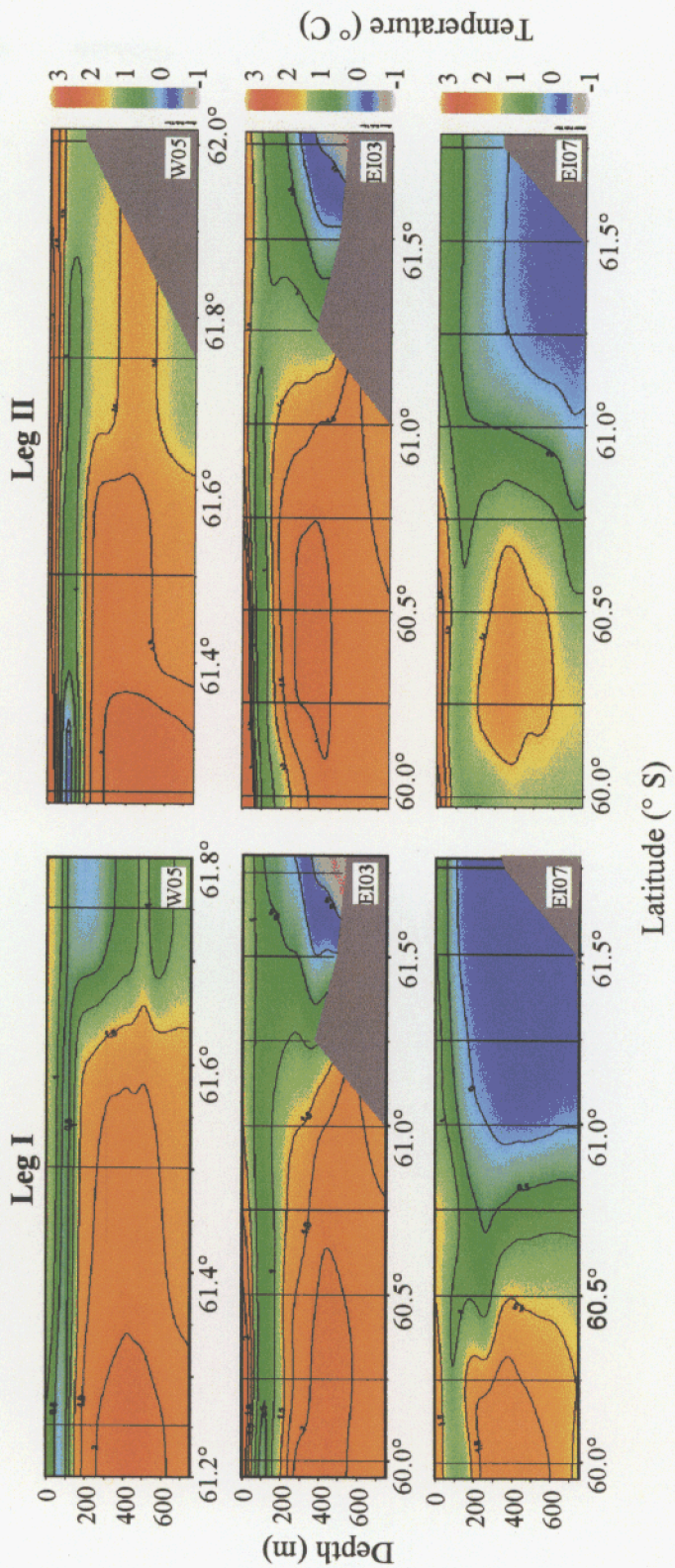


Figure 1.3. Vertical temperature profiles derived from CTD data recorded on three transects, W05 (top), EI03 (middle) and EI07 (bottom), during Legs I (left col.) and II (right col.) of the AMLR 2001/02 South Shetland Island survey. Note that station A13-09 (Leg I) was aborted due to bad weather.



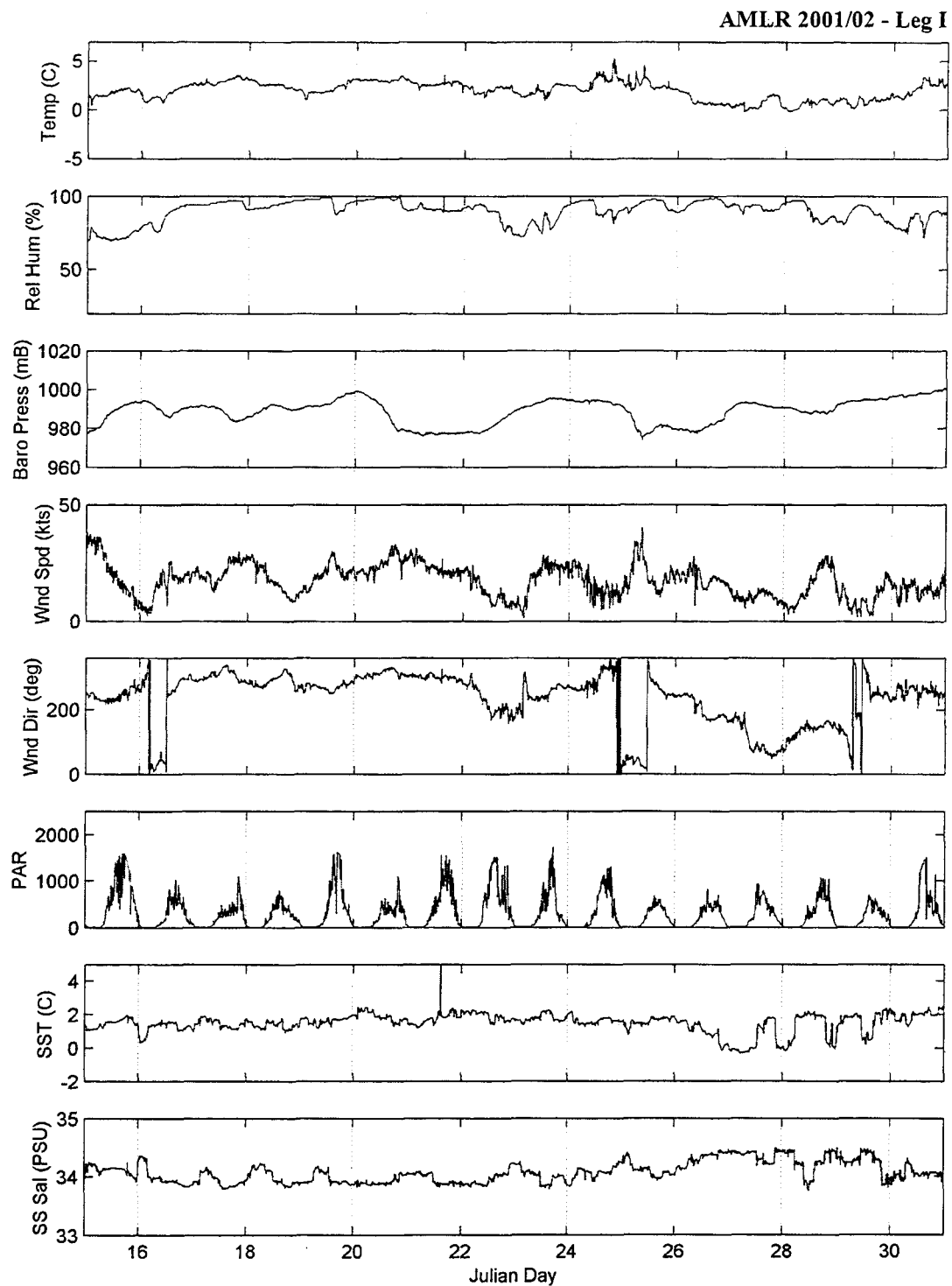


Figure 1.4. Meteorological data (5-minute averages) recorded between January 16th and January 29th during Leg I of the AMLR 2001/02 cruise. (PAR is photo-synthetically available radiation).

AMLR 2001/02 - Leg II

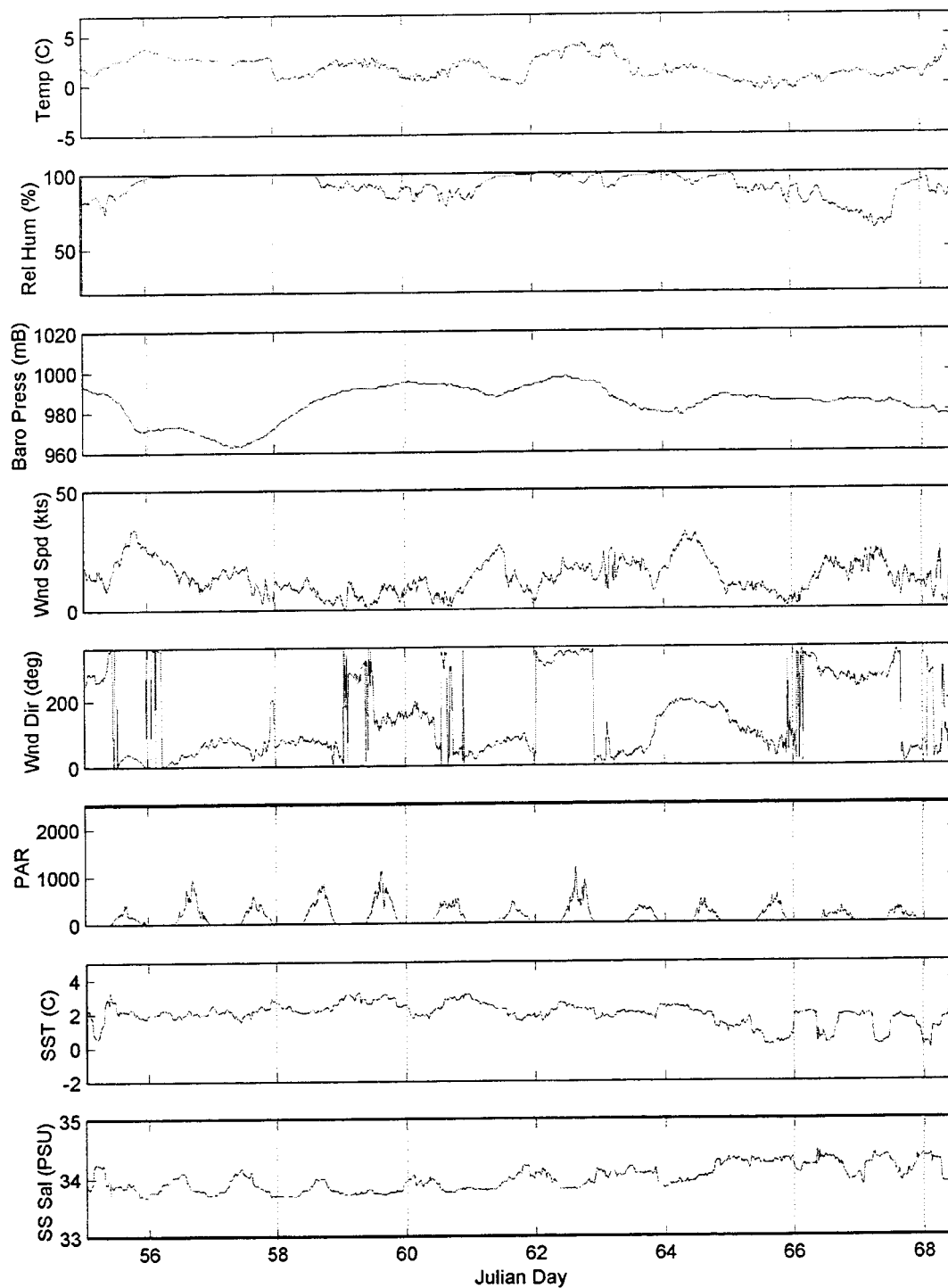


Figure 1.5. Meteorological data (5-minute averages) recorded between February 24th and March 9th during Leg II of the AMLR 2001/02 cruise. (PAR is photo-synthetically available radiation).

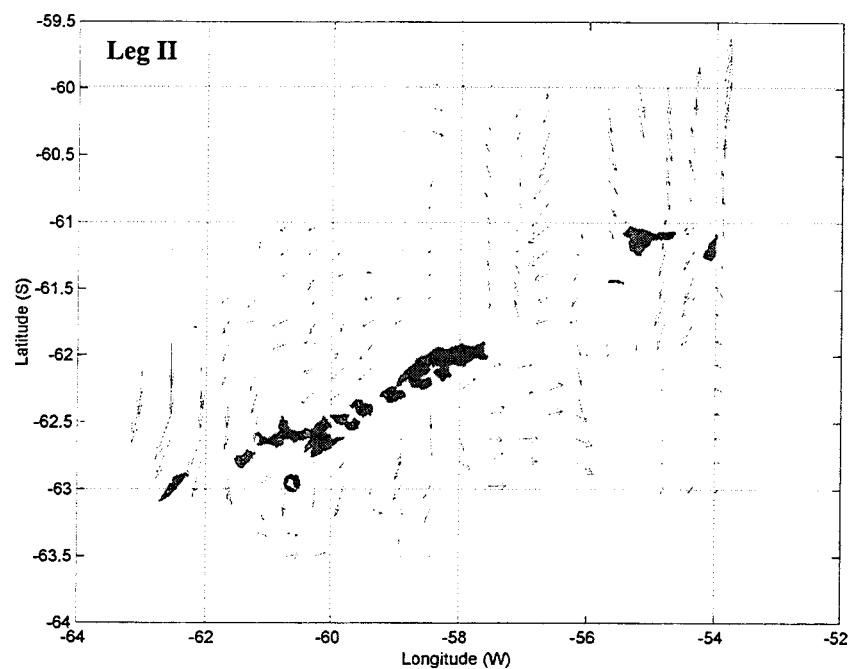
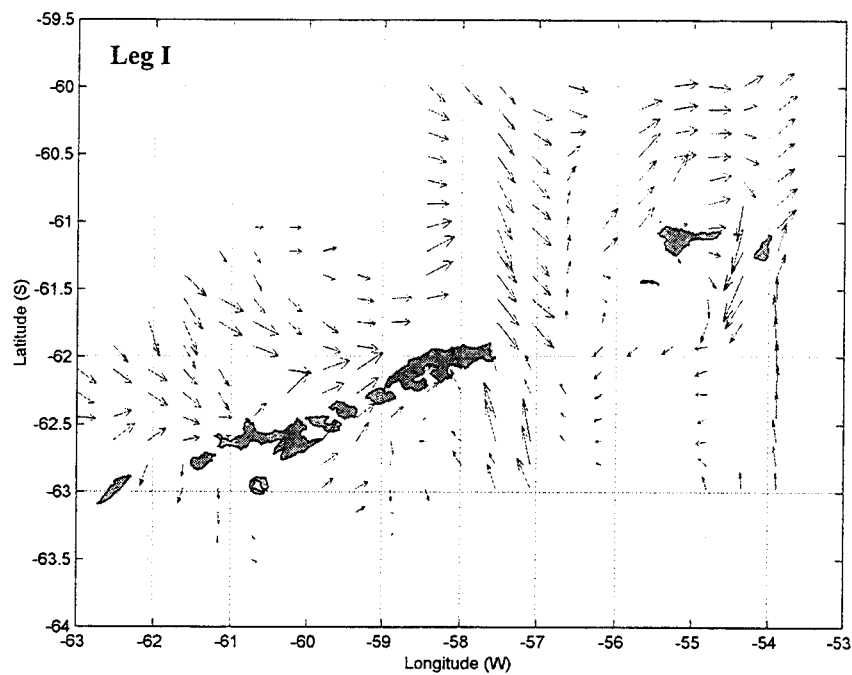


Figure 1.6. Vectors representing wind speed and direction for Legs I (top) and II (bottom) derived from data recorded by the SCS logging system during the AMLR 2001/02 survey of the South Shetland Islands.